

PULMONARY FUNCTION STUDIES IN 15 TO 18 YEARS AGE WORKERS EXPOSED TO DUST IN INDUSTRY

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Abstract: Pulmonary function tests (VC, FEV₁ and FEF_{25-75%}) were evaluated in 15 to 18 years age workers employed in slate pencil industry exposed to silica dust, in wool carpet industry exposed to wool dust and in diamond cutting and polishing exposed to carbon dust. These values were compared with the values obtained in clinically healthy non-smokers of the same age group. The results revealed significant impairment of VC in diamond workers, and FEF_{25-75%} in slate pencil workers. When the values were observed according to smoking habits in diamond workers, VC, FEV₁ and FE_{25-75%} were all significantly reduced in smokers whereas in non-smokers only VC was lowered significantly. Among slate pencil workers FEF_{25-75%} was significantly reduced in both smokers and non-smokers. Wool dust exposed workers showed reduced values than normal subjects. The detailed results including the prevalence of various pulmonary impairments were presented.

Key words : pulmonary function dust industry

INTRODUCTION

The minimum age prescribed for employment varies from industry to industry. The minimum age for underground mine work is 16 years, while for work above the ground is 15 years. The minimum age prescribed in Factories Act is 14 years and in the Plantations Labour Act (1951) is 12 years. In certain industries like beedi making, carpet weaving, cement manufacturing, the minimum age for employment is 15 years. There is a Central Government directive to the States to ban employment of children under 14 in the building construction industry (1).

The biggest drawback of the child Act is that 'child' defined differently from State to State. In Madhya Pradesh, Uttar Pradesh and Punjab, a child means a person under 16 years, in Saurashtra and West Bengal, a person under 18 years, in Telangana, a person under 14 years. In Union Territories, a child is defined as a boy under 16 years or a girl under 18 years. Some states like Nagaland, Orissa, Sikkim and Tripura have yet to enact a legislation for children for the health of child workers. As for legal safeguards the

law requires medical examination of children upto 18 years of age, and that too only for industrial employment. But no standards have been laid down for medical fitness (3). A large number of workers of 15 to 18 years age are engaged in dusty occupations such as slate pencil industry, wool carpet weaving, diamond cutting and polishing and it is necessary to evaluate health hazards in this age group of workers. In this study, pulmonary function status in the above age group workers employed in slate pencil, wool carpet weaving and in diamond cutting and polishing factories was assessed.

METHODS

In occupational health surveys conducted in slate pencil industry, wool carpet industry and diamond cutting and polishing, workers in the age group of 15 to 18 years were also screened for clinical and pulmonary function studies. The number of workers examined in slate pencil industry were 58 males and 4 females, wool carpet industry 76 males and 16 females and in diamond cutting and polishing only 45 male workers. Their occupational history, smoking

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habits and physical findings were noted. Pulmonary function test (PFT) values (VC, FEV_{1%} and FEF_{25-75%} values were noted. These PFT values were compared with the values obtained in clinically healthy non-smokers of 15 to 18 years age group reported by Jain and Ramaiah to find out any deviation attributable to dust exposure.

The percentage of predicted VC value was obtained for each workers using the regression equation of Jain and Ramaiah (2). The diagnosis of restrictive impairment was made based on percentage of predicted VC value of < 80.0% below obstructive impairment was diagnosed based on a FEV_{1%} value below 75.0%. The prevalence of these impairments was estimated.

RESULTS

Table I shows the percentage of workers in the age group of 15 to 18 years in the studies on slate pencil, diamond and wool carpet industry. A total of 11.1 percent male and 5.6 percent females in slate pencil industry, 22.5 percent males in diamond industry, 11.7 percent male and 8.1 percent females in wool carpet industry are in this age group.

TABLE I : Percentage of workers of 15-18 years age in the studies done in dusty industries.

| Group | Slate Pencil | Diamond | Wool Carpet |
|--------|----------------------|----------------------|----------------------|
| Male | N - 522 58 (11.1) | N - 200 45 (22.5) | N - 650 76 (11.7) |
| Female | N - 71 4 (5.6) | Nil | N - 198 16 (8.1) |

N = Total number of subjects.

Figures in parenthesis indicate percentage.

Physical findings and PFT values are given for clinically normal and dust exposed male workers in Table II. The height and BSA are matching comparatively between clinically normal and dust exposed workers. Compared to clinically normal's VC value, a significant loss in VC in diamond workers, and reduced values in slate pencil and wool carpet workers was seen. The FEV_{1%} value is decreased in all dust exposure groups than normal subjects. A significant reduction in FEF_{25-75%} value in silica dust exposed

workers in slate pencil industry and low value in diamond workers was also demonstrated.

TABLE II : Physical findings and pulmonary function values in clinical normal, and dust exposed workers in 15-18 years age (Male).

| Parameter | Clinically normal N=21 | Dust exposed | | |
|------------------------------------|---------------------------|----------------------|-----------------|---------------------|
| | | Slate Pencil N=58 | Diamond N=45 | Wool Carpet N=76 |
| Height (cms) | 161.3±11.9 | 163.8±8.5 | 161.3±5.8 | 161.5±6.7 |
| BSA (m ²) | 1.49±0.14 | 1.44±0.09 | 1.43±0.09 | 1.48±0.11 |
| Duration of exposure (yrs) | — | 3.81±2.33 | 2.73±1.99 | 2.43±1.39 |
| VC (lit) | 3.59±0.55 | 3.47±0.64 | 3.17±0.50* | 3.47±0.71 |
| FEV _{1%} | 89.1±4.6 | 86.8±7.4 | 87.8±6.5 | 87.3±6.9 |
| FEF _{25-75%} (lit/sec) | 3.90±0.76 | 3.19±1.06* | 3.46±1.09 | — |

* = Significant at 5% level compared to normal.

PFT values when observed according to smoking habits and compared with clinically normal non smoker value, (Table III) revealed significant VC reduction in both smokers and non-smokers. In diamond workers, significant reduction in FEV_{1%} and FEF_{25-75%} in smokers of diamond workers, a significant reduction in FEF_{25-75%} in both smokers and non-smoker of slate pencil workers. All other values are reduced in both smokers and non-smokers than clinical normal value.

Physical findings and PFT values in 15 to 18 years age females exposed to dust is given in Table IV. The prevalence of different ventilatory impairments in dust exposed males and females in 15 to 18 years age is given in Table V. Among slate pencil workers, in males the prevalence of restrictive impairment was seen in 12 (20.7%), obstructive impairment 4 (6.9%) and both restrictive and obstructive impairment 1 (1.7%) whereas in females only 1 (25.0%) exhibited both restrictive and obstructive impairment. In case of diamond cutters (only males) restrictive impairment occurred in 16 (35.5%) and obstructive impairment 3 (6.7%). In wool carpet male workers restrictive impairment was prevalent in 14 (18.4%) workers, obstructive impairment 2 (2.6%) and both restrictive

and obstructive impairment in 2 (2.6%) whereas females demonstrated restrictive impairment in 4 (25.0%) and both restrictive and obstructive impairment 1 (6.2%).

DISCUSSION

This study revealed that a considerable percentage of workers are engaged in dusty industries are in the age group of 15 to 18 years. In these industries, male workers are exposed to silica dust in slate pencil industry for a mean duration of 3.81 years, in diamond cutting and polishing industry exposed to carbon dust for a mean duration of 2.73 years and for wool dust in wool carpet industry for a mean duration of 3.47 years (Table II). A reduction of lung volume and obstruction in smaller airways in diamond workers, an impairment in smaller airways in silica dust exposed workers was demonstrated and is irrespective of smoking habit (Table II & III). In male children rapid growth occurs at 13 and

TABLE III: Pulmonary function values according to smoking habits in 15-18 yrs age dust exposed workers (Males only)

| Parameter | Clinically normal N=21 | Slate Pencil N=12 N=46 | | Diamond N=32 N=13 | | Wool N=55 N=21 | |
|------------------------------------|---------------------------|---------------------------|----------------|----------------------|-----------------|-------------------|--------------|
| | | N.S. | S | N.S. | S | N.S. | S |
| VC (lit) | 3.59 ±0.55 | 3.47 ±0.64 | 3.46 ±0.53 | 3.17* ±0.53 | 3.11* ±0.51 | 3.41 ±0.69 | 3.65 |
| ±0.77 | | | | | | | |
| FEV _{1%} | 89.1 ±5.6 | 86.9 ±7.6 | 86.7 ±7.7 | 88.8 ±6.2 | 82.5* ±9.8 | 87.8 ±7.1 | 86.2 ±6.6 |
| FEF _{25-75%} (lit/sec) | 3.90 ±0.76 | 3.17* ±1.40 | 3.20* ±0.97 | 3.63 ±1.17 | 3.05** ±0.79 | — | — |

* = Significant at 5% level compared to clinical normal group.

** = Significant at 1% level compared to clinically normal group. 17 years (3) and this includes the growth of the respiratory system. Growing lung is susceptible to the effects of the inhaled dust (4) and this might be responsible for the present findings in slate pencil and diamond workers. It is also known that the primary target area of inhaled pollutant or dust are the smaller airways (5) and this is well demonstrated in slate pencil and diamond workers. In wool carpet industrial workers, FEF_{25-75%} parameter was not evaluated and hence the results were not presented.

TABLE IV : Physical findings and pulmonary function values in 15-18 yrs age dust exposed females.

| Parameter | Slate Pencil N = 4 | Wool Carpet N = 16 |
|----------------------------|-----------------------|-----------------------|
| Height (cms) | 146.0 ± 2.94 | 154.3 ± 6.7 |
| BSA (m ²) | 1.22 ± 0.02 | 1.39 ± 0.08 |
| Duration of exposure (yrs) | 4.25 ± 2.50 | 4.12 ± 2.44 |
| VC (lit) observed | 2.38 ± 0.32 | 2.63 ± 0.77 |
| % of predicted | 99.5 ± 14.2 | 93.6 ± 24.5 |
| FEV _{1%} | 79.7 ± 21.2 | 89.2 ± 6.7 |

The occurrence of smaller airway obstruction in slate pencil workers irrespective of smoking habit may also be due to exposure to very high levels of respirable dust than the prescribed threshold limit values (TLV) (6). The effect of wool dust on respiratory function showed significant impairment in maximal expiratory flow rate at 50.0% of the vital capacity and in FEV_{1%} was observed (7) and this finding was not exhibited in the present workers and it may be that they were exposed to dust for only 2.43 years and the air-borne dust concentrations in wool industry was also below the TLV value (8).

TABLE V : Prevalence of ventilatory impairment in dust exposed male and females 15-18 yrs age.

| Type of impairment | Slate Pencil N=58 N=4 | | Diamond N=45 | Wool Carpet N=76 N=16 | |
|-----------------------------|--------------------------|-------------|-----------------|--------------------------|-------------|
| | Male | Female | Male | Male | Female |
| Restrictive | 12 (20.7) | Nil | 16 (35.5) | 14 (18.4) | 4 (25.0) |
| Obstructive | 4 (6.9) | Nil | 3 (6.7) | 2 (2.6) | Nil |
| Restrictive and Obstructive | 1 (1.7) | 1 (25.0) | Nil | 2 (2.6) | 1 (6.2) |

N = Total number of workers.

Figures in parenthesis indicate percentage.

The demonstration of higher prevalence of restrictive impairment in slate pencil and diamond workers may be due to development of interstitial fibrosis. Silica dust (9) and diamond dust (10) are known to produce fibrosis and hence restrictive impairments. Over all, this study showed that employment of 15 to 18 years age group workers in dusty occupation produces pulmonary impairment. Hence preventive measures should be taken.

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